

Remarks

Claims 1-23 are pending in this application. Claim 1 has been amended to specify that the metallocene compound contains a metal bound to one or more cyclopentadienyl ligands. Applicants submit that this amendment does not narrow the scope of the claim in any way. Claim 12 has been amended to specify that the layer is deposited on the exposed copper surface. Claims 2 and 16 have been amended to delete repeated recitations of cobalt and claim 18 has been amended to correct a typographical error.

Summary of Interview

Applicants thank the Examiner for the courtesy of the telephonic interview with Applicants' representative on May 15, 2006. During the interview, the rejection of the present claims under 35 USC § 102(a) as being anticipated by Lopatin et al. US Patent Application No. 2005/0085031 ("Lopatin") was discussed. It was agreed that only the subject matter in Lopatin supported by provisional application No. 60/511,993 may be relied upon to make the rejection. The Examiner stated that the rejection is supported by paragraph [0040] of the provisional application, contending that a metallocene by definition is any ligand bound to a metal, and specifically citing the various borane complexes, e.g., a dimethylamine borane complex, listed in paragraph [0040] as a metallocenes.

Rejections Under 35 USC § 102

All claims have been rejected under 35 USC § 102(a) as being anticipated by Lopatin et al. US Patent Application No. 2005/0085031 ("Lopatin").

As argued in Applicants' previous response, Lopatin may not be properly used as a 102(a) as its publication date of April 21, 2005 is after Applicants' filing date of February 3, 2004. Also as argued in Applicants' previous response, if used as 35 USC § 102(e) reference, only subject matter in Lopatin supported by provisional application No. 60/511,993 may be relied upon to make the rejection.

The December 6, 2005 Office Action and Final Office Action both cite various sections of Lopatin (e.g., paragraph [0083]) that are not supported by the provisional application. Because these sections may not be properly used in the rejection, Applicants requested in their previous response and during the telephonic interview that the Examiner cite the specific sections of the provisional application that properly support the subject matter relied upon to make the rejection.

As indicated above, during the interview, the Examiner agreed that only the subject matter in Lopatin supported by provisional application No. 60/511,993 may be relied upon to

make the rejection. The Examiner has now provided citations to the provisional application that are relied upon for the § 102 rejection, specifically, paragraphs [0005], [0007] and [0040] of the provisional application. Applicants refer to these and other relevant sections of the provisional application (hereinafter "the '993 application") in the remarks below.

First, with regard to the Examiner's contention that "[a] ligand bound to a metal is a metallocene composition by definition," Applicants refer to paragraphs [0010] and [0011] of Applicants' specification, wherein it states:

Any metallocene that protects exposed copper surfaces from oxidation may be used. Generally, metallocenes are of the form bis-(cyclopentadienyl)-metal, including various substituted cyclopentadienyl groups. Examples of the metal include ruthenium, iron, nickel, cobalt, magnesium, palladium, platinum, titanium, chromium, osmium, manganese and combinations thereof.

The cyclopentadienyl ligands of the metallocene compounds may include any number of substituents on one or more of the groups. These substituents are typically alkyl or alkene groups, whose number, size, and location may be chosen to affect the steric properties of the compound and/or its volatility. The substitution pattern may be symmetric or asymmetric. Also included are bent and half metallocene structures as are known in the art.

Applicants also have enclosed a definition of metallocene from the "Encyclopedia of Chemistry," as well as the "Metallocene" entry from Wikipedia. It is clear from these references that it is well-known that "metallocene" is not by definition "any ligand bound to a metal" but a class of compounds in which one or more cyclopentadienyl ligands are bonded to a central metal atom (e.g., in the case of a half metallocene, one cyclopentadienyl ligand).

However, to expedite prosecution, Applicants have amended the claims to explicitly recite that the compound contains one or more cyclopentadienyl ligands bound to a metal atom. Applicants submit that this amendment does not narrow the scope of the claim in any way, as evidenced by the above-cited sections of Applicants' specification as well as the provided references.

The '993 application describes protecting copper from oxidation by capping the copper with a CoW layer. Because copper-CoW adhesion is poor, an "activation alloy" layer is deposited on the copper, prior to deposition of the CoW cap layer (paragraphs [0006] and [0012]). The activation alloy layer is deposited to provide strong adhesion between the conductive layer and the capping layer [0008].

The only mention of a metallocene compound in the '993 application is in a very limited application, specifically as one of many possible copper precursors in deposition of a PdCu activation alloy layer by an atomic deposition layer (ALD) process (see paragraphs [0068]-[0073]). As described in the '993 application, "a pulse of gas containing a copper precursor and a palladium precursor is delivered and chemisorbed to the substrate surface. A pulse of reducing

agent is delivered to the substrate and reacts with the chemisorbed layer to produce a PdCu alloy layer. This cycle is repeated to grow a PdCu alloy layer.” (paragraph [0071])

This use of a copper precursor is very different from the use of metallocenes in the methods of Applicants’ invention. The methods of Applicants’ invention involve using metallocene compounds to passivate or minimize the formation of copper oxide on the exposed copper surface. Once passivated, the exposed copper surface may then be exposed to oxidizing environments, e.g., during deposition of a barrier layer on the copper, without significant copper oxide formation. In some embodiments, the methods of the invention eliminate the need for a capping layer to protect the copper from oxidation. By contrast, the copper metallocene in the ‘993 application is adsorbed (with a palladium precursor) onto the exposed copper, then reacting with a reducing agent to form a CuPd alloy, onto which a capping layer is deposited.

Applicants’ claim 1 recites exposing the copper to a metallocene compound, then contacting the exposed copper surface to an oxidizing environment wherein the exposure to the metallocene compound minimizes formation of copper oxide on the exposed copper surface. Nothing in the ‘993 application teaches or suggests that the exposed copper surface is exposed to an oxidizing environment. Rather, in the ALD process described in the ‘993 application, the exposed copper is exposed to alternating pulses of the copper metallocene and a palladium precursor and a reducing agent to form a CuPd alloy. There is also no teaching or suggestion that this ALD process step would minimize formation of copper oxide on the exposed copper surface.

Claim 12 recites passivating the copper surface by exposing the surface to a metallocene compound and then depositing a layer on the exposed copper surface using an oxygen-containing chemistry. This is not taught or suggested by ‘993 patent. The layer deposited on the exposed copper surface using the copper metallocene compound as described in the ‘993 patent is a CuPd alloy, which is deposited in some embodiments using the copper metallocene and a palladium precursor. There is also no teaching or suggesting that this metallocene compound passivates the exposed copper surface. (It should be noted that the reference to passivation in paragraphs [0005] and [0007] of the ‘993 application cited by the Examiner appear to refer not to the activation alloy adhesion/CoW capping layers described in the ‘993 application but to various prior solutions).

In addition to being patentable for the reasons given above, Applicants submit that various dependent claims are independently patentable. For example, claims 3 and 16 recite ruthenocene compounds. No ruthenocene compounds are taught or suggested by the ‘993 application.

CONCLUSION

Should the Examiner believe that a telephone conference would expedite the prosecution of this application, the undersigned can be reached at the telephone number set out below.

Respectfully submitted,

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